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Why the Fish Failed

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WHY THE FISH FAILED

A STORY OF POTASH

By

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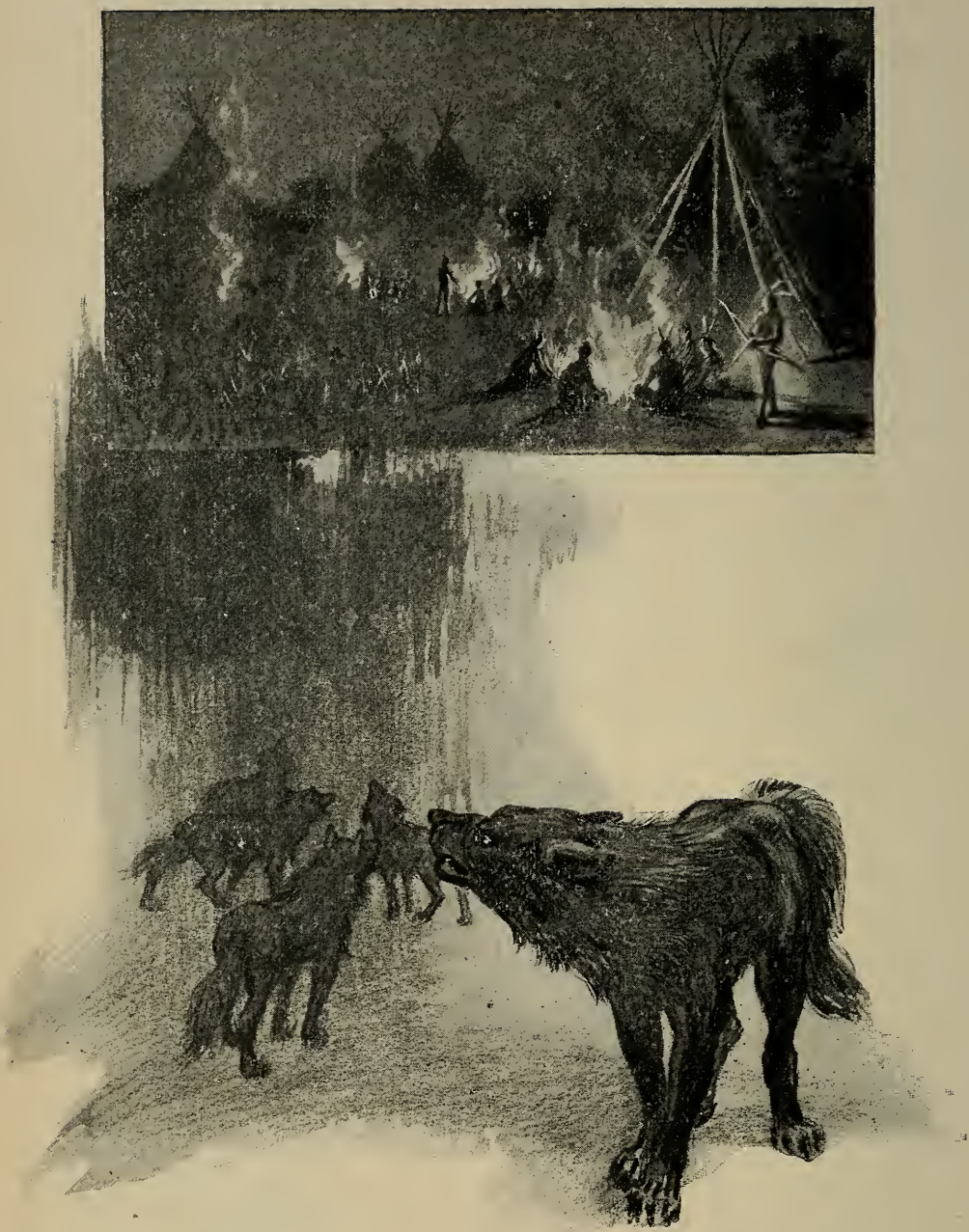


MY father's old garden at Plymouth, Massachusetts, has, I am sure, produced at least 275 annual crops for white men, and nobody knows how many more for the Indians. It was no rich virgin soil that the Pilgrims found at Plymouth in 1620. The soil was naturally thin, and had already been in cultivation for years. The Indians had practiced a rude sort of farming,—stirring the soil with shells and sticks and planting corn, beans and few vegetables. The pilgrims started with what we call "abandoned land." They made it productive and in doing so, worked out one of the great problems that have followed the farmer for centuries. They learned the "how" of making that poor soil produce a crop. Had they known the "why" as we know it to-day, the whole history of New England farming would have been changed.

These Pilgrims were not farmers by trade. Few, if any, had ever had any experience in farming or producing food. If they had, they probably would not have tried to grow crops on these abandoned fields at Plymouth. Even the Indians were better farmers

than these Whites. Naturally they went to the Indians for instruction. A friendly Indian named Squanto taught them how to raise corn on poor land. Squanto was thus the first American Experiment Station director. Early in the spring large numbers of small fish rushed up the river. It was noticed that the Indians caught and saved many of them,—beyond what they needed for food.

When corn planting time came, Squanto scooped a hole in the ground, put in two of the dead fish, scattered a bit of sand over them, planted his seed, hilled it up, and called his job done. Squanto was neither the first nor the last teacher of practical agriculture, who has had scoffers in his class-room. The Pilgrims, like many farmers who have lived since their time, were somewhat set in their ways and had never

Squanto

before heard of this manuring with dead fish. They doubted their teacher's wisdom, but as he had a corn crop to show, they finally planted their doubts with the fish and followed his methods. They were wise, for the corn prospered and in time gave a good yield.

The Corn Prospered

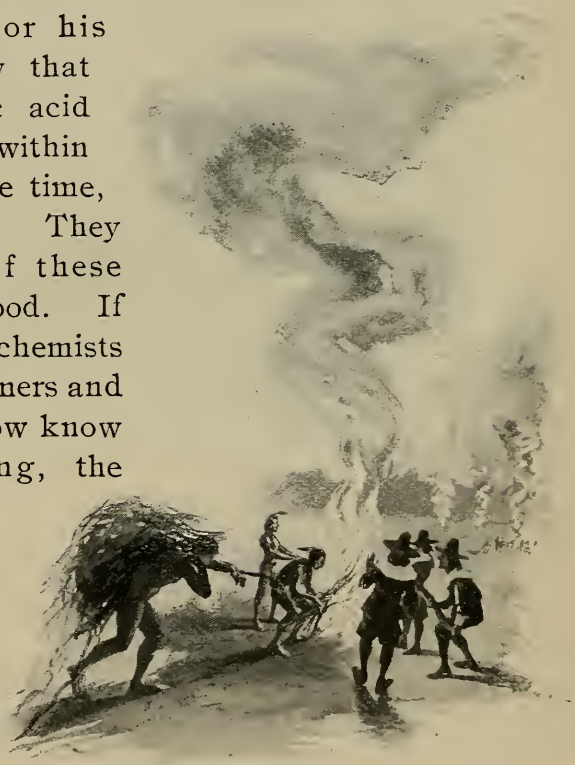
The Pilgrims thought that settled the corn question, for the sea was full of fish and land was abundant. After a few years, however, there came a new trouble which they did not understand. In spite of the fish, the corn began to yield less and less grain when planted in that field. They used twice as much fish and still there was little grain, though the stalks were tall and thrifty. In these days the experiment stations would quickly tell us the "why" of this, but Squanto never pretended to be an "agricultural chemist." All he knew was, that when fish failed to make a good crop of corn, the "why" of it never filled his stomach in winter. It was then time to leave that field and take another piece of ground. The Pilgrims were not disposed to

The Fish Failed

be original and so they did the same. They noticed that while the field was abandoned, it was not idle. A natural growth of weeds, grass and brush or little trees grew up and in a few years made a thick growth. It was found, somewhat by accident, that if this natural growth was burned on the ground, a little coat of ashes would be left and then, strange to say, several more good corn crops could be grown if fish were used in the hill. This was probably the first attempt at a "rotation" on an American farm. Corn was grown until it failed to respond to the fish. Then, when the soil was left alone, a new crop came in, worthless in itself, yet, when cut and burned, gave the fish such help that it could produce more corn. Of course, this led to experiments with wood ashes. It was found that such ashes used in the hills with the fish made the crop sure. Great brush heaps could be burned in some convenient place and the ashes collected. A handful of the ashes, with a couple of fish, gave a better hill of corn than a dozen fish used alone!

Now, why did the ashes help the fish? What did they do, or what lack did they supply? If the Pilgrims had known what we now know, there would be very few abandoned farms in New England to-day. When a man is farming on rich, Virgin soil, the *why* of things need not bother him much, but when he is on soil that needs help of some sort, the *why* becomes master, for without knowing it, we can not feed the soil economically. An empty stomach, which is the most forcible teacher in the world, convinced both White and Red man, that fish alone would not produce corn year after year, and so they hunted up new land just as thousands of other farmers have done since their time.

You must remember that neither Squanto nor his White friends knew that nitrogen, phosphoric acid and potash must be within reach of plants all the time, if we expect a crop. They had never heard of these elements of plant food. If one of our modern chemists had gone to these farmers and told them what we now know about plant feeding, the

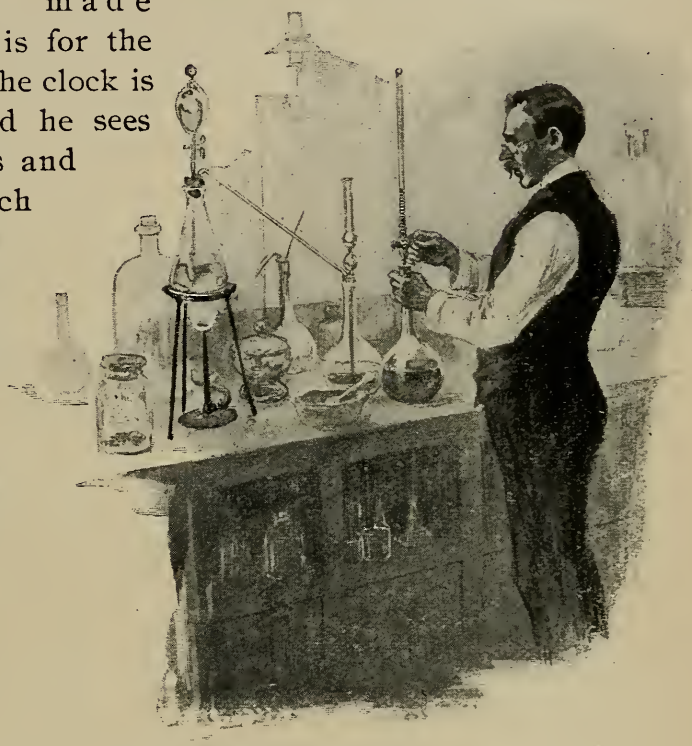


Burning Brush for the Ashes

chances are, that they would have whipped him out of town at the tail of a cart. It was more than two centuries before the common people even began to realize what it means to provide a balanced ration for a crop, and that there must be all the fertilizing elements present in the soil if we hope to grow a crop.

WHO LEARNED THE *WHY* OF IT?

THE chemists dug away at this old problem until they picked the fish and the corn apart. Then it was made easy as it is for the boy when the clock is opened and he sees the springs and wheels which make the hands go. The chemists found among other things, the following:



POUNDS IN ONE TON.

	NITROGEN	PHOSPHORIC ACID	POTASH
Fish,	100	110	None
Corn,	32	12	7
Corn Stalks,	12	4	20
Wood Ashes,	None	35	100

A study of this table proves that the fish failed not because it was "bewitched," or because the farmers had committed some sin, but because it added no potash to the soil. The *why* is easy when we get at it in this way.

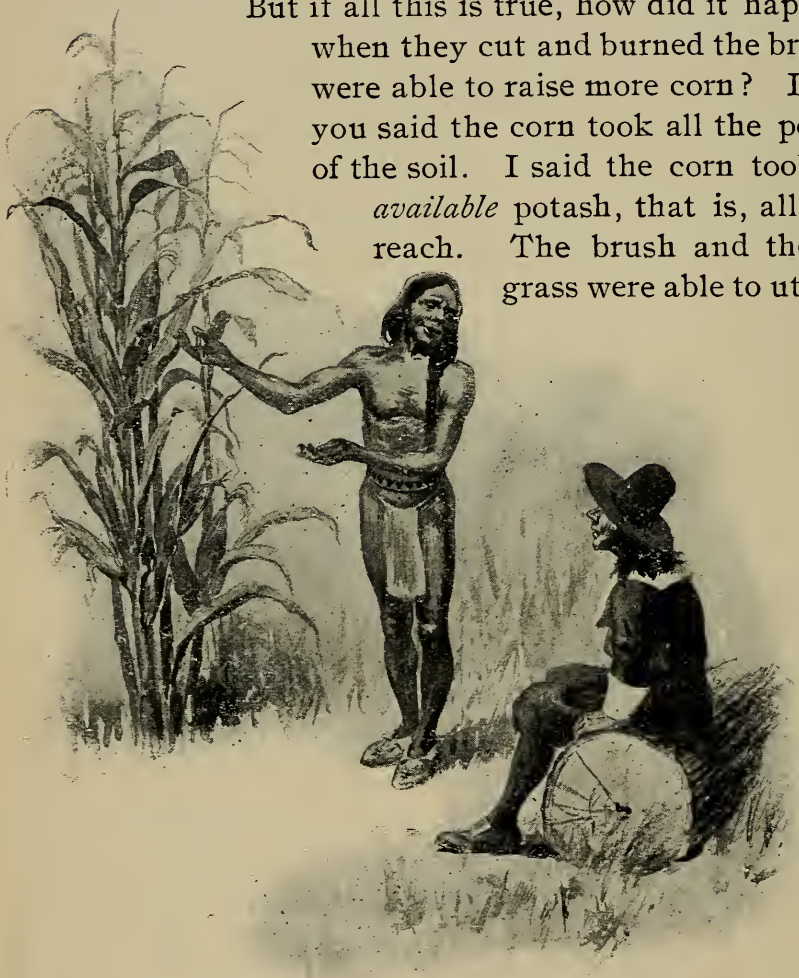
In order to produce fifty bushels of shelled corn and two tons of fodder, which go with such a yield, it would be necessary to have in the soil where the crop could easily reach it, not far from seventy pounds of nitrogen, twenty-five pounds of phosphoric acid, and fifty pounds of potash. The soil itself to begin with was poor. The Indians knew that, because they knew that unless the fish were added, they had no corn. We see from this table, that when they kept on using fish year after year, they put nitrogen and phosphoric acid in the soil, but no potash. For several years the corn crop made a fair growth on the potash it could find in the natural soil. When this supply failed, since no more was added with the fish, of course, the plant could not perfect its ear since there is nothing that can take the place of potash in the growth of the plant. The Pilgrims found that out to their cost, and all that chemists have learned since then, only goes to prove that no other element can do the work in plant feeding which nature has assigned to potash. We must understand this fact about the three leading elements of plant food. Nitrogen promotes growth; phosphoric acid gives frame and shape, not unlike the bony skeleton in the living body; potash controls the living functions of the plant, gives it character and life, in one way like the blood and vital force. These elements can not "change works,"

each has its separate part to do, and if one is lacking, it is the lack of that one and not the abundance of the others that will determine the crop. The Pilgrims used fish until there was far more nitrogen and phosphoric acid in the soil than was needed, yet it was of no use to the corn because there was no potash.

The little pinch of potash contained in the ashes did the corn more good than ten fish would have done, because the fish contained no potash whatever. The result would have been much the same, if, after learning that wood ashes were so valuable, these early farmers had concluded that there was no sense in using any more fish. They probably would have tried that, if the fish had cost money. They might have burned down the forest and thus obtained ashes enough to fertilize their fields year after year. After a few years the corn would have refused to grow. It would have dwarfed from head, shoulder and waist, finally to knee high. The reason for this will be as clear as daylight when we look at our table, for we notice that while the ashes would supply potash and phosphoric acid, there is no nitrogen, and as soon as the supply of that material already in the soil is exhausted, the plant refuses to grow. If the fish be put with the ashes, the corn grows because in this way nitrogen is added. A farmer can not have this truth too clearly in mind, all three of the fertilizing elements must be present if we expect a crop. These early farmers found that their hardest problem was to provide a supply of potash and that has been the trouble with every generation of farmers since then. This is because the fertilizers found naturally in

American soils contain nitrogen and phosphoric acid, while there is no natural supply of potash except in wood ashes. More crop failures have resulted in this country as a result of a lack of potash, than from any other fertilizing cause, because, as was the case with Squanto and his white pupils, potash is not found in sufficient quantities in ordinary fertilizers.

But if all this is true, how did it happen, that when they cut and burned the brush, they were able to raise more corn? I thought you said the corn took all the potash out of the soil. I said the corn took all the *available* potash, that is, all it could reach. The brush and the coarser grass were able to utilize sup-



Ashes Added to Fish— More Corn

plies of potash, which were beyond the power of the corn to absorb. When these hardier plants were burned, the potash in the ashes was made available for the corn crop. Suppose you turn a tame house-dog out in the woods and make him stay there. The chances are, that he would starve. Turn a woodchuck or fox of the same weight into the woods, and he would make a good living because he and his ancestors before him have been obliged to hunt for their food. Kill those animals and let the dog eat them and he will grow fat. All soils contain potash, but it is mostly "locked up" in forms which place it beyond the reach of the cultivated crops. Wild crops, like wild animals, are able to obtain supplies of food which would baffle their cultivated cousins, so that when a field is given up and "abandoned," it may slowly become productive again. There might be potash enough in one acre of soil to produce 1,000 annual crops of corn, and yet it might be so insoluble that the corn would not grow until 100 pounds of *available* potash were scattered over the acre.

We know better now than to let a field grow into brush and course grass in order to obtain available potash. We buy the potash outright and feed it to such crops as clover and cow peas. These crops utilize more of the natural potash in the soil and when they are plowed under or fed to the stock and brought back to the soil as manure, increased crops of corn, or potatoes, or other food crops may be grown. It is safe to say, that if Squanto or the White men had known what we know about fish and why it failed after some years of cropping, the history of New

England farming would have been changed greatly. As we will see, it was chiefly the lack of available potash, certainly next to the shortage of nitrogen, that made New England farming unprofitable, and sent so many of the best boys and girls West, after "stronger land." As they go West, the same old trouble that puzzled Squanto is sure to confront them, because the chief fertilizers used in this country are acid phosphate and slaughter-house refuse like blood, tankage or bone,—or ground fish. These fertilizers contain no potash and so crops finally begin to fail just as they did when fish alone was used on the corn. The reason is the same, for while land may be rich in nitrogen and well fed with phosphate, it will fail in potash unless that element is supplied.

Now, the stock or dairy farmer will say that this does not apply to him, because he uses manure and thus keeps up a full supply of potash.

"Where do you get this potash?"

"Why, I buy a lot of it in my grain!"

You should not be too sure of that,—Squanto and his White friends would have said much the same about their fish. Let us not guess about it, but apply the same test that we did to the fish and the corn.

Here is another table:

Pounds in One Ton.

	Nitrogen	Phosphoric Acid	Potash
Stable Manure,	10	6	12
Wheat Bran,	45	56	28
Corn Meal,	32	6	3
Brewer's Grain,	15	9	1
Cottonseed Meal,	80	60	29

I mentioned these feeds as they are such as a dairy man would buy. You will see when a man buys grain, he brings to his farm fair quantities of nitrogen and phosphoric acid, but much less potash. It is not as bad as was the case with the fish, for that had no potash at all, but you will see that in all these grains potash is lacking as compared with the others. Thus, when the farmer feeds the hay and fodder grown on his own farm and buys grain, he does not add nearly as much potash as he may think.

You will notice also in this table, how the potash compares with the other elements in stable manure. On an average soil, which has been cropped for some years, it is a safe rule to use with each pound of nitrogen, three pounds of phosphoric acid and at least two and a half pounds of potash. There are soils, no doubt, where this proportion would not be profitable, but unless a farmer has tested his own soil and *knows* better, he should be sure and use potash enough. Let farmers think of the potato fertilizer which has given them profitable crops. Does it not always contain two and sometimes *three* times as much potash as it does of nitrogen? We see at a glance that stable manure does not supply any such proportions for both potash and phosphoric acid are lacking. This being the case, you can easily see, that in order to obtain the potash which our crops need, we must use so much of the stable manure that there will be a waste of nitrogen. That was what happened in the case of our old friend Squanto. When the corn crops began to fail, he used more and more fish. Had there been a little potash in the fish, he could have made his corn

crop by using large quantities of fish, but most of the nitrogen in it would have been wasted. Had he been obliged to pay for the fish, he would soon have been forced out of business as a farmer. Now, stable manure costs money, and when a farmer uses it as Squanto used the fish, he is sure to lose both cash and crop. If a pound of potash costs 4½ cents, and a pound of nitrogen costs 16 cents, where does a farmer's profit come in when he uses two pounds of nitrogen more than he needs in order to obtain one pound of potash?

This point has been made clear by Prof. Wm. P. Brooks, at the Massachusetts Agricultural College. He experimented with soil which was not unlike that which Squanto used for the first experiment farm. Prof. Brooks knew that the soil lacked potash. Our old friend Squanto did not know what the soil needed, so he kept on adding fish in the vain hope that nitrogen or phosphoric acid would take the place of

the needed potash. Farmers who use stable manure without thinking what it contains, would have followed Squanto's lead and kept on using more manure without knowing that every pound of potash added in this way meant the loss of a pound of nitrogen. Prof. Brooks knew that potash was the needed element in that soil. Very likely he had used muriate of potash alone on separate rows or parts of the field, and thus found that crops responded to it. You will remember that Squanto did this same thing when he used wood ashes, but he had no chemist to tell him the *Why* of the *How*. Prof. Brooks had the advantage of Squanto in knowing that the stable manure contained and what the soil and the crop needed. On one field or plot he used manure at the rate of six cords per acre. This cost $30. and would be called fair manuring. On another field of equal size he used four cords of manure and in addition 160 pounds of muriate of potash per acre, this costing less than $24. This was kept up for several years and different crops were grown. Actual count and measurement showed that the average yield of corn was just as large where the $24. worth of manure and potash was used as where the $30. worth of manure alone was put. Here was a saving of $6. an acre each year, which is large interest on $100. With the grass crop the yield with the large amount of manure was a little larger but not enough larger to make up the increased cost of the manure. That is, the four cords of manure and potash gave a cheaper ton of hay! Now we have only to look back to the table in order to see why this was so. The four cords of manure

provided all the nitrogen which the corn crop needed. The four cords, however, did not contain enough potash, and had this amount been used alone, Prof. Brooks could not have grown a full crop. The muriate of potash which was added "balanced" the nitrogen and thus made the full crop possible. The saving of $6. per acre meant the amount of nitrogen in the extra two cords of manure which were in excess of the actual needs of the crop. On some soils phosphoric acid must be added in the same way, and this could be done by using three hundred pounds of acid phosphate with the manure. Let us remember that stable manure is useful to the farmer chiefly for the nitrogen which it contains. We all understand that where fruit or vegetables are grown, or where fertilizers are the main reliance for plant food, potash must be used freely. We must also understand that on dairy farms or where grass and corn are grown, and milk and stock are sold, potash is greatly needed.

Why is that so?

Look back at the table showing the analysis of grains and feeds and you will see that there is less potash in them than of either nitrogen or phosphoric acid. While a farmer who buys grain may secure considerable nitrogen and phosphoric acid, the supply of potash is but little increased.

But does not this show that because there is less potash in these grains, this element is not so necessary as the other?

Not at all. We might analyze a man or a horse and find little or no potash in his body, and therefore, conclude that this element is not needed. This would

be as absurd as to claim that because we cannot analyze a man's strength of will or character, therefore he has none! Here we come to the reason for using an abundance of potash which is often over-looked. Potash, more than any other element, has to do with the *vital functions* of the plant. Unless it be present in the plant, the formation of starch and the processes which correspond to digestion in animals cannot go on. While nitrogen and phosphoric acid remain largely in the body of the plant or animal, potash affects the vital functions and then is passed away. It is thus fully as necessary as the others, while we can easily see that the amount of it, which remains stored up in the body, is no measure for its actual importance. To illustrate, we might prove by the analysis of an ox, that water, lime, nitrogen and phosphoric acid are needed to perfect its body, but such analysis would not show the actual need of air any more than it would the need of potash. Yet who would take that analysis and try to prove that the ox does not need an abundance of air? For example, the grain of corn shows a low proportion of potash and yet this small amount determines the quantity and quality of the crop, for corn is largely composed of starch and potash is needed to form it. A farmer may add nitrogen to his soil by growing clover or cow peas, but he can only add potash by buying it in grains or fertilizers.

There is another thing to be considered. The farm is more likely to loose the fertilizing effect of the potash purchased in grain than of the other elements. The greater part of such potash is voided in the liquid

manures. As we have said, the potash is not stored up in the body as the other elements are. It serves its purpose in aiding digestion and then passes away, chiefly through the kidneys. In a ton of liquid manure from a horse there are thirty pounds of potash, while in a ton of pure solids there are only seven pounds. This proportion is larger still with cattle and sheep. When we know this, we can see how easily potash is lost to the cultivated fields. A large proportion of the liquids are voided in the pasture or on the road, so that much of the potash bought in the grain never reaches the fields where crops are grown. It is true that quantities of nitrogen and phosphoric acid are also lost in this way, but there are more of these in the grain to begin with, while the proportion of potash in the liquids is higher. This being so, we can readily see how in the average manure pile, the loss of potash by leaching must be considerable.

From every point of view, therefore, we see the necessity of keeping up the supply of available potash. Some soils contain ample supplies of it while others are nearly exhausted though rich in other elements. The old problem of baiting the dead fish with wood ashes in order to catch the corn, is repeated over and over again. We may now make sure of our ground for when a crop responds to an application of muriate of potash, we may be sure of what the soil needs, for there is nothing but potash in the muriate that would help. We have learned how to obtain cheap supplies of nitrogen by plowing under green crops. Cheap phosphoric acid can be obtained from a dozen different sources. Potash is still the hardest element to supply

and yet its presence in the soil still determines the character of the crop. When Squanto and his class in agriculture failed to raise corn, they knew where to get a supply. The Indians along the mouth of the Connecticut River rarely failed to grow corn and had grain to sell. No doubt the Pilgrims wondered why these Connecticut Indians could grow corn with fish, while at Plymouth the fish failed after a few crops. We should probably find now that these Connecticut Indians occupied soil that was naturally richer in potash and hence responded to the fish. In modern times the famous red apples of the Ozark region in Missouri have become famous the world over for their size, color and firmness. It is now found that the subsoil and the flat surface stones in that "Land of the Big Red Apple" are rich in potash. Connecticut fruit growers with a less fertile soil have been able by the use of good culture and a high per cent. of potash in their fertilizers to back up the following legend which was exhibited at the last meeting of the Connecticut Pomological Society:

"Not the land of the *big* red apple, but the land of the *good* red apple!"

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